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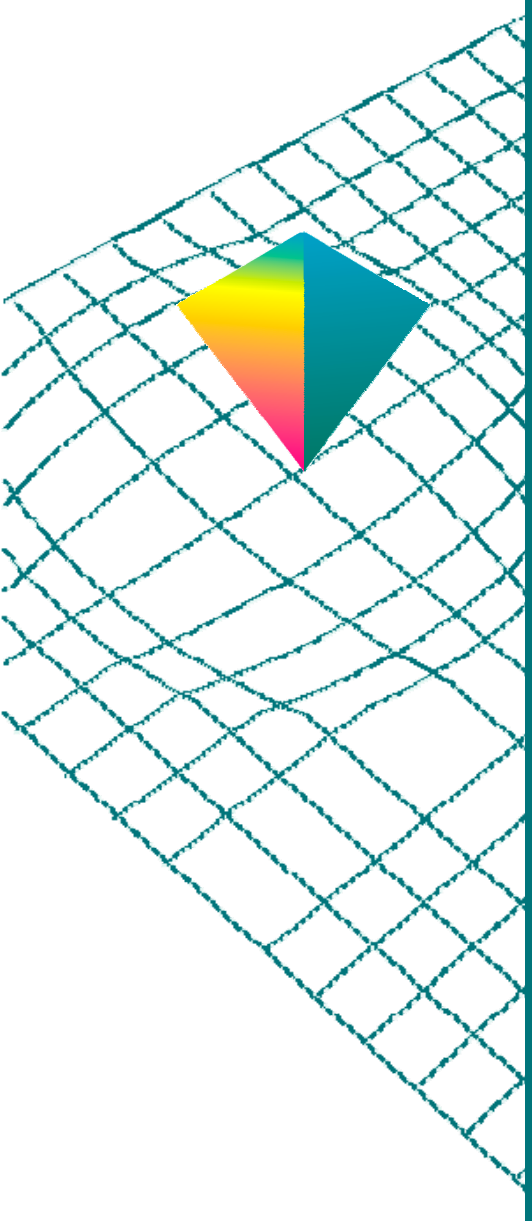

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M. Pinotti / A. Casagrande / S. Del Vecchio / F. Soares / R. Utsch

Dynamic test system for evaluating physical integrity of devices employed in cardiac surgery with extracorporeal circulation

ABSTRACT

Cardiac surgery with cardio-pulmonary bypass is an established procedure. Blood oxygenator and arterial line filter play an important role while blood is pumped through the extracorporeal circuit. Since these devices are disposable, made of injected polycarbonate, they are massively produced. There are international standards that regulate the fabrication and testing blood oxygenator and arterial line filters. However, only the static pressure loading is well established. It is known that the extracorporeal circuit pressure oscillates with frequency in the range of 0.5 to 2 hertz and, consequently, the study of the response of the disposable devices under such conditions is desirable. The aim of the present work is to describe the dynamic pressure loading test system (DPLTS) to evaluate the physical integrity of medical devices (blood oxygenators and arterial line filters) usually employed in cardiac surgery.

INTRODUCTION

Cardiac surgery with cardio-pulmonary bypass is an established procedure. The blood is pumped through the extracorporeal circuit and there are three devices playing important roles. The blood pump plays the part of the patient heart, the blood oxygenator plays the part of the patient lungs and arterial line filter collects particles with dimensions smaller than 40 microns from the blood stream. The blood oxygenator and the arterial line filter are made of injected Polycarbonate and they are disposable. Since all the patient blood is passing through the extracorporeal circuit during the cardio-pulmonary by-pass, a fault in one of its component results in obit to the patient. There are International Standards which regulates the fabrication and testing blood oxygenator and arterial line filters. However, only the static pressure loading is well established. Knowing that the peristaltic pump is the most employed in the open heart surgery and by its operation the pressure in the extracorporeal circuit the pressure oscillates with frequency in the range of 0.5 to 2 Hertz, the study of the response of the disposable devices under this condition is desirable. The aim of the present work is to describe the Dynamic Pressure Loading Test System (DPLTS) to evaluate the physical integrity of medical devices (blood oxygenators and arterial line filters) usually employed in cardiac surgery.

METHODOLOGY

Dynamic Pressure Loading Test System is made of Polipropilene semitransparent box (Fig.1), where the device is installed to the test circuit. Demineralised water was employed as working fluid and the dynamic pressure loading were achieved using a pneumatic system. The pressure was controlled by an electro-pneumatic valve and measured by piezoelectric sensor. The valve control and the pressure sensor signal were acquired and processed.

(a) (b)

Figure 1 – (a) General view of the testing system, (b) Arterial line filter installed for testing.

RESULTS

Three types of filters were tested. The loci of roots of the damped frequency, the natural frequency and the damping factor are shown in Fig.2 for an arterial line filter for frequency of 0.5 and 2 Hertz.

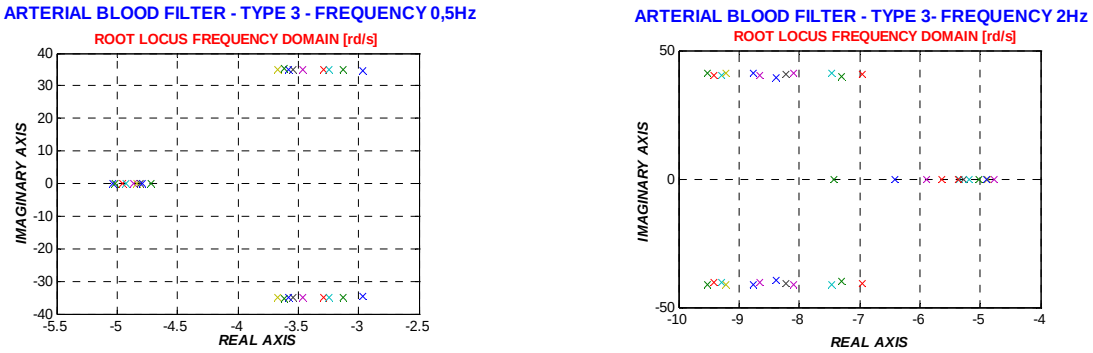

Figure 2. Root loci for 0.5Hz and 2.0Hz.

CONCLUSIONS

It was possible to analyse the roots loci, the tested devices stability and the predominant behaviour of first and second orders.

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